Preliminary observations, on the breeding of pearl oysters, *Pinctada fucata* (Gould) of the Gulf of Kutch[1]

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(*With two text-figures*)

The pearl oysters of the Gulf of Kutch breed twice in a year. The primary breeding season is during winter, i.e. December to January, which is followed by a secondary less significant breeding period in early summer, i.e. April to May.

The stimulus for breeding does not appear to be in relation to the changes in salinity and temperature, as there is great variation in the salinity and temperature values during these two breeding seasons.

Introduction

While the biology of the pearl oysters of the Gulf of Mannar has been studied in detail by Herdman (1903-06), Hornell (1916 & 1922) and Malpas (1929 & 1933), those in the Gulf of Kutch have not received much attention in this regard. Hornell (1909) and Easwaran, Narayanan & Michael (1969) concentrated mainly on the fishery aspects and Gokhale, Easwaran & Narasimhan (1954) and Narayanan & Michael (1968) dealt mainly with the dimensional relationships of these bivalves. So much so, the biology in general, and the breeding habits in particular, of the oysters of this locality have not been studied by previous authors. This paper presents the preliminary observations made on the breeding habits, with particular reference to the spawning season of the pearl oysters of the Gulf of Kutch. The present studies

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form a part of the scheme for research and investigation on the pearl oysters of the Gulf of Kutch, implemented by the Directorate of Fisheries, Government of Gujarat, through its Research Station at Jamnagar.

I have made a detailed study on the taxonomy of the Gulf of Kutch pearl oysters and find them to be the typical Indian species referable to *Pinctada fucata* (Gould, 1850: *Proc. Boston. Soc. Nat. Hist.* **3**: 309-312) [Syn. *Pinctada vulgaris* (Schumacher)], which nomenclature is used in this paper. No other species of the Genus *Pinctada* (Bolten) has been observed in the collections from this locality.

Materials and Methods

About five hundred oysters collected from the pearl oyster *Khaddas* of the Gulf of Kutch and reared in a Sea Water Tank at Sikka (Jamnagar District, Gujarat State) by the Fisheries Research Station, Government of Gujarat, Jamnagar, constitute the material for the present studies. Regular samples of living oysters were measured, weighed and their gonads examined afresh every fortnight. Side by side, the salinity and temperature of the sea water of the tank were also recorded regularly.

As adopted by Gokhale *et al.* (1954) and Narayanan *et al.* (1968), the thickness denotes the maximum distance between the external surfaces of two valves and hinge-width the maximum distance between the edges of the two valves at the hinge. The whole-weight indicates the weight of the animal inclusive of the valves and flesh-weight, the weight of the body exclusive of the valves. (Special care has been taken to see that the water particles are blotted out from the flesh to the maximum possible extent and to obtain the accurate weight of the flesh). The linear measurements, referred to above, were made with a pair of Dial Calipers and represented in millimeters. The flesh and whole weights were measured in a Chemical Balance and represented in grammes.

For the sake of convenience, the gonads were classified into five stages, basing on their stage of development, as follows:

Stage 0 : Resting/Immature Gonad
Stage I : Developing Gonad
Stage II : Ripe Gonad
Stage III : Running or Oozing Gonad
Stage IV : Spent Gonad

While classifying the gonads, as above, there were a few oysters whose gonads could not be catagorised, as the gonad-development was too obscure. Such gonads are indicated as 'Un-identified Gonads'.

Observations on the gonads and their contents were made from fresh specimens only, so as to avoid any shrinkage of the tissue. Body dimensions and stage of development of the gonads were recorded against each specimen at regular intervals.

Observations

It has been observed, as a general rule, that a male gonad is creamy white and the female gonad yellowish to dark-yellow in external appearence, when they are fully ripe. However, at times when the gonad is infested by a trematode parasite[1]—which is a very common phenomenon in the Gulf of Kutch oysters—the external coloration of the gonads of either sex is pinkish-red.

The age at first maturity of these oysters has not been correctly estimated so far. Tranter (1958a & 1958d) has observed that the Australian pearl oysters, *Pinctada albina* (Lamarck) and *Pinctada margaritifera* (Linnaeus) attain sexual maturity around the first year of their life. Gokhale *et al.* (1954) contended that the Gulf of Kutch oysters attain sexual maturity towards the third or fourth year. I do not agree with their view, as on many occasions I have examined the gonads of oysters of below one year, one year and two years and have found them to be fully ripe. My observations reveal that, in general, the Gulf of Kutch pearl oysters attain sexual maturity at a hinge-width of 2 to 2.5 mm and a thickness of 18 to 22 mm. Narayanan *et al.* (1968) have observed that the mean thickness and hinge-width of these oysters at the end of the first year are 21.9 mm and 2.5 mm respectively. This, therefore, should mean that the age at first maturity of the pearl oysters of this locality cannot be more than one year. Unfortunately, no definite conclusion can be arrived at in this regard and the exact age at which these oysters attain sexual maturity cannot be pin-pointed, as I have not examined sufficiently large number of oysters of one year and below.

The percentage of sex of the pearl oysters of the Gulf of Mannar has been estimated by Hornell (1916) as 55 males to 45 females. Tranter (1958d) observed the proportion of sex of *Pinctada margaritifera* (Linnaeus) of the Australian waters as five males to every female. In the Gulf of Kutch, however, the percentage of male and female has been worked out as 35.5 and 64.5 respectively.

Tranter (1958c) observed that the ratio of sex decreases until in old oysters the proportion is equal. According to him, such a pronounced variation is the result of a sex-change within the population.

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[1] The taxonomy of these parasites has not been worked out as yet.

Ojima & Maeki (1955) noted bi-sexual nature in the gonads of *Pinctada martensii,* but Herdman & Hornell (1903, 1904 & 1906) though recognizing the possibility of a sex-change in oysters, stated that their species (*Pinctada fucata*) was permanently dioecious. Wada (1938 & 1953) showed that *Pinctada martensii* and *Pinctada maxima* experienced change of sex.

The possibility of such a change of sex in the Gulf of Kutch oysters cannot altogether be ruled out as on many occasions my samples consisted only of one sex. But the data in this connection is not sufficient to substantiate this view. Also, it has not been possible for me to observe the same stock of oysters over a long period.

Breeding Season

The stage of development of the gonads examined afresh was determined and the percentage of each stage of development was worked out month-wise, as tabulated in Table 1.

As can be seen from the table, a great majority of the oysters were found to be in the resting stage during the months of June, July and August. In October, however, majority of the gonads were ripe and in November and December, oozing (running) ones formed the major percentage. In January and February, the spent gonads were more than those of the other stages. In March, about a third of the oysters were found to ripen again. In April, these were found to be in the running (oozing) stage and in May most of them were either spent or resting. These observations indicate that the actual or the primary breeding season of the pearl oysters in the Gulf of Kutch is November, December and January. This primary breeding season is followed, in some cases, by a secondary one in April-May.

The observations made on the whole weight- flesh weight relationship and other studies made on the seasonal variations in oysters also support this view.

The mean percentage of the flesh-weight in the whole-weight of the individual oysters were estimated monthwise and is shown in Fig. 1. As can be seen from the figure, the percentage of flesh-weight in the whole-weight increases from November onwards and this increase lasts up to February, after which the percentage falls. Again, from March onwards up to May there is an increase in the percentage. The percentage decreases in June, July, August and September. The whole-weight of the oysters includes the shells also, but the flesh-weight, on the other hand, indicates only the weight of the body within the shells. Since during sexual development, the gonads extend to almost all parts of the viscera, there are all possibilities of increase in

TABLE 1

Stage of Gonad Development	Monthwise percentage of different gonad stage											
	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY
Stage '0'	93.80	90.30	87.00	67.40	20.00	05.00	—	—	35.50	21.30	40.00	47.00
Stage 'I'	—	02.70	08.00	25.60	23.00	17.00	02.00	—	04.5	33.7	—	—
Stage 'II'	—	—	—	06.00	55.00	24.00	20.0	--	—	22.0	26.0	—
Stage 'III'	—	—	—	—	—	53.00	70.0	23.6	—	02.0	30.5	14.0
Stage "IV"	—	—	—	—	—	—	06.0	75.4	60.0	20.0	3.5	39.0
Unidentified	6.20	7.00	05.0	01.00	02.00	01.00	02.00	01.00	—	01.00	—	—

the weight of the body. Hence, the increase in the percentage of flesh-weight in the whole-weight during the months of November-January and March-May invariably indicates the excessive gonad development and hence breeding season.

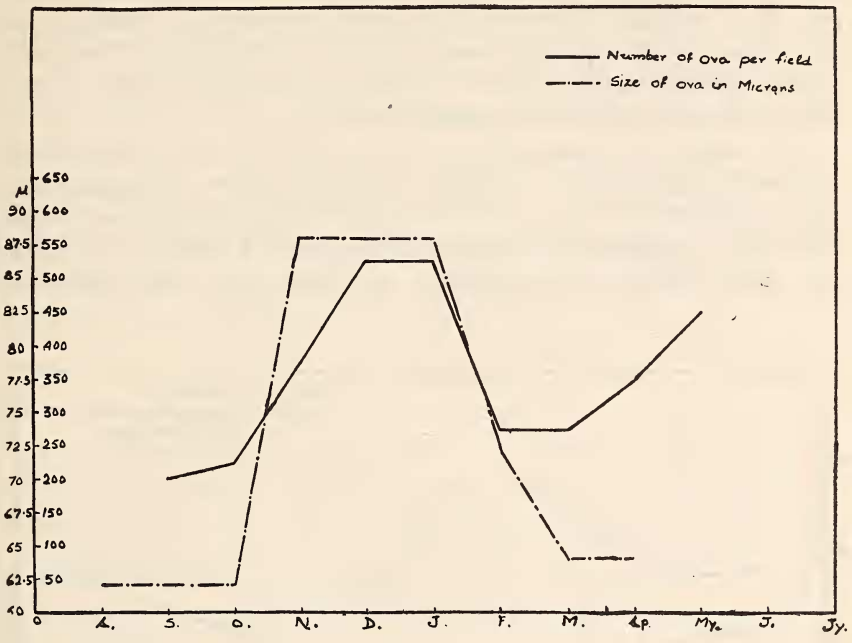

Fig. 1

Similarly, changes in the gonadial elements were also observed during the breeding season. The average ova count per field and the mean size of the ova were also found to increase corresponding to the breeding peaks. These changes have been plotted in Fig. 1.

As observed by Easwaran *et al.* (1969), there are no heavy spat-falls observed in the Gulf of Kutch, unlike in the Gulf of Mannar and Palk Bay. However, I have collected a few three to four month-old spats from the Pearl Oyster Reefs of Movada, during March-April, 1966. These spats, though scanty, do indicate that the oysters of the Movada Reef had bred somewhere between November, 1965, and January 1966.

Temperature and Salinity

Herdman & Hornell (1906), Hornell (1916) and Malpas (1929) have estimated that the Ceylonese and South Indian pearl oysters breed

twice in a year, namely during the south-west monsoon and north-east monsoon seasons. The present observations show that the pearl oysters of the Gulf of Kutch also breed twice in a year; but the breeding maxima do not tally with those in the Gulf of Mannar and Palk Bay. This is probably because the hydrological conditions in the Gulf of Kutch are entirely different from those in the Gulf of Mannar and Palk Bay. Malpas (1929) believes that the changes in salinity and temperature induce the pearl oysters to spawn. According to him, high salinity in July-August and low salinity in December-January in the southern waters both act as breeding stimuli.

The salinity and temperature of the Gulf of Kutch have been recorded regularly by the Fisheries Research Station, Jamnagar, and are shown in Fig. 2. As can be seen from the figure, there is not much appreciable variation in the salinity of the Gulf of Kutch waters. This has been observed by Gokhale *et al.* (1954) also. The maximum

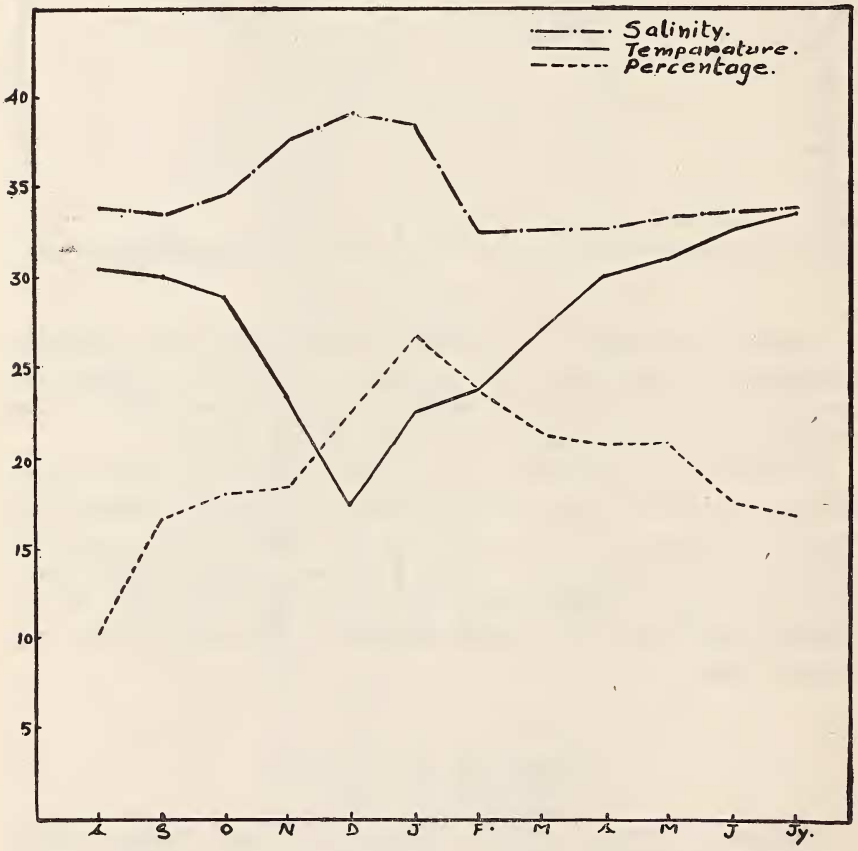

Fig. 2

salinity observed is 39‰ in December and minimum 32.18‰ in February-March. During the primary breeding season of the pearl oysters of this locality, the salinity is the maximum (37 to 39‰) and during the secondary breeding season, in April-May, the salinity is minimum (32.18 to 31.8‰). Malpas' (1929) contention that the oysters get spawning stimulii from both high and low salinity may appear to be quite true in regard to the pearl oysters of the Gulf of Kutch. But, as Dewanesan & Chidambaram (1956) put it, it will not be justifiable, though it cannot be proved with the information on hand, to believe that an animal can respond to different stimulii in the same manner.

Similarly, the contention that temperature variation too stimulates the pearl oysters to breed cannot be agreed to, as the mean temperature during the primary breeding season in December-January is 17.5 to 23.5°C and during the secondary breeding season, in April-May, the temperature ranges between 30 to 31°C (Fig. 2).

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